REMARKS

Applicants wish to express sincere thanks to the Examiner for a thorough examination of this application, and the insights provided at the interview on September 20, 2005. Claims 6, 7, 12, 19, 20 and 25 have been allowed. Applicants also respectfully submit that Claims 1-5, 8-11, 13-18, 21-24, and 26 should also be allowed in view of the following submission, or otherwise put in condition for appeal.

Claims 1-5, 8-11, 13-18, 21-24, and 26 have been rejected under 35 U.S.C. § 103(a) as being obvious in view of Kumai, et al. U.S. Patent No. 4,073,643. The previous final rejection of Claims 1-5, 8-11, 13-18, 21-24, and 26 under 35 U.S.C. § 102(a) for anticipation over Kumai, et al., U.S. Patent No. 4,073,643 has been withdrawn. Specifically, the Examiner cited Kumai for disclosing a method of producing thin cast strip with low surface roughness and low porosity by continuous casting comprising the steps of: introducing molten steel having a total oxygen content of at least 100 ppm and free oxygen content between 30 and 50 ppm between the pair of casting rolls to form a casting pool between the casting rolls at a temperature such that a majority of the oxide inclusions form therein are in liquidus state (co. 2, lines 14-30 and table 4).

In fact, Kumai does not disclose or suggest thin strip casting **in any** form, let alone by twin roll casting or more specifically introducing molten steel between the casting rolls where the molten steel has a total oxygen content of at least 100 ppm *and* a free oxygen content between 30 and 50 ppm as claimed in claim 1. First and foremost, the present claims are directed to a method making thin steel strip by use of a twin roll casting process. This process is wholly different from the continuous slab casting method of making steel slabs disclosed in the Kumai '643 patent. A continuous slab caster operates wholly different using wholly different apparatus from a twin thin strip caster.

The Kumai '643 patent discloses a method for production of continuously cast steel slab for use in manufacturing steel sheet having excellent workability by lowering the silicon (Si) level to less than 0.02% Si. The design of a continuous slab casting machine and the thickness of the cast slabs that are produced by this method described in Kumai are well known. As shown by Chapter 15, entitled "The Design of Flat and Long Products Casters," of the Casting Volume of *The Making, Shaping and Treating of Steel* (11th edition), the molten steel is poured from a ladle into a tundish, and then through a

submerged entry nozzle into an oscillating mold where the steel is moved from a downward vertical direction to a horizontal direction as the molten steel cools where the cast slab emerges from the mold. This is shown in Figure 15.4 of Chapter 15. The design of the continuous casting method is also shown by Figure 6.1 of Chapter 5 of Casting Volume of *The Making, Shaping and Treating of Steel.* Copies of Chapter 15 and Figure 6.1 of Chapter 5 of the Casting Volume of *The Making, Shaping and Treating of Steel* are attached as Addendum A hereto. Further, the thicknesses of cast slabs in thick slabs are 7-12 inches, in medium slabs are 4 ¼ -7 inches, in medium thin slabs are 2 ¾ - 4 ¼ inches, and in thin slabs of 1 ½ - 2 ¾ inches (with the thin slabs developed after 1976). See Figure 15.2 of Addendum A hereto.

In continuous slab casting there is no cooled casting rolls forming a nip between them, no casting pool between a pair of casting rolls, no counter rotating of casting rolls to form shells on the casting rolls and no forming of shells into strip at the nip between the casting rolls. Accordingly, there is no disclosure or suggestion in the Kumai '643 patent any disclosure or suggestion of **any** of the specified elements of the presently claimed method set forth in independent claim 1(and its dependent claims 2-5, 8-11 and 13):

> a. assembling a pair of cooled casting rolls having a nip between them and with confining closures adjacent the ends of the nip;
>
> b. introducing molten low carbon steel having a total oxygen content of at least 100 ppm and a free oxygen content between 30 and 50 ppm between the pair of casting rolls to form a casting pool between the casting rolls;
>
> c. counter rotating the casting rolls and solidifying the molten steel to form metal shells on the surfaces of the casting rolls with levels of oxide inclusions reflected by the total oxygen content of the molten steel to promote the formation of thin steel strip; and
>
> d. forming solidified thin steel strip through the nip between the casting rolls from said solidified shells.

Similarly, there is no disclosure or suggestion in the '643 patent of **any** of the elements of the presently claimed method set forth in independent claim 14 (and its dependent claims 15-18, 21-24 and 26):

a. assembling a pair of cooled casting rolls having a nip between them and with confining closures adjacent the ends of the nip;

b. introducing molten low carbon steel having a total oxygen content of at least 70 ppm and a free oxygen content between 20 and 60 ppm between the pair of casting rolls to form a casting pool between the casting rolls;

c. counter rotating the casting rolls and solidifying the molten steel to form metal shells on the surfaces of the casting rolls with levels of oxide inclusions reflected by the total oxygen content of the molten steel to promote the formation of thin steel strip; and

d. forming solidified thin steel strip through the nip between the casting rolls from said solidified shells.

Specifically, Kumai et al. '643 does not disclose **any of the following:**

a. assembling a pair of cooled casting rolls having a nip between them and with confining closures adjacent the ends of the nip;

b. introducing molten low carbon steel having a total oxygen content of **[any amount]** and a free oxygen content between **[any amounts]** between the pair of casting rolls to form a casting pool between the casting rolls;

c. counter rotating the casting rolls and solidifying the molten steel to form metal shells on the surfaces of the casting rolls with levels of oxide inclusions reflected by the total oxygen content of the molten steel to promote the formation of thin steel strip; **[or]**

d. forming solidified thin steel strip through the nip between the casting rolls from said solidified shells.

Moreover, Kumai is concerned with free oxygen content of the steel for a wholly different reason than the presently claimed method. Kumai is concerned with the silicon content in the steel and the impact of *free* oxygen on making steel with a low silicon content. At col. 2, lines 26-27, Kumai states that the *free* oxygen is not more than 150 ppm. At col. 7, line 63 through col. 8, line 4, Kumai describes the goal of the deoxidation process as proceeding until the *free* oxygen content is lowered to 150 ppm or less. Again, in col. 9, lines 3-4, "The free oxygen content after these treatments was not more than 100 ppm." Finally, in Table 4, the initial section lists the *free* oxygen (F.O.) for various samples for the Blowing-Off Composition in Converter, which is prior to vacuum

degassing. The next section lists the *total* oxygen (T.O.) for the Composition of Molten Steel After Tapping, which is also prior to vacuum degassing. In the third section of Table 4, Kumai lists the *free* oxygen after Vacuum Degassing. Nowhere does Kumai disclose or suggest the free oxygen levels of the presently claimed method.

Further, Kumai does not disclose or suggest the *total* oxygen specified in the presently claimed method, where the molten steel is introduced between casting rolls when thin strip casting. The only references in Kumai to *total* oxygen is in reference to blowing off, see for example, col. 2, lines 16-17, " ...blowing molten steel to a total oxygen content between 600 ppm and 1600 ppm.... " Because of the subsequent steps of vacuum degassing and deoxidation adjustment with additives, it is not possible to reach any conclusion based on Kumai as to a relationship between the blowing off total oxygen content and the total oxygen content at the time of casting.

Kumai does not disclose or suggest the method of making steel strip as claimed by Applicants in claims 1 or 14 where the *total* oxygen must exceed the *free* oxygen by at least 50 ppm, claim 1, or by at least 10 ppm, claim 14. Rather, the '643 patent teaches that this method is provided by first producing steel with a "blowing-off" oxygen level between 600 and 1600 ppm in the finished steel in a converter. As the '643 patent specifically instructs:

> "As noted, it is an important object of the present invention to improve the workability of both hot and cold rolled steel sheets by lowering the silicon content to less than 0.02%. For this purpose, it is essential that the steel be blown to an oxygen content from about 600 to 1600 ppm. This relatively high oxygen content is maintained for the specific object of lowering the silicon content.

'643 patent, Col. 7, ll. 50-57.

In the Kumai '643 process, the molten steel, with an extremely reduced silicon content in the converter, is then tapped into a ladle "where required amounts of low-carbon Fe-Mn, high carbon Fe-Mn, and carbon are added," and the molten steel is subjected to vacuum degassing treatment to reduce both the carbon and oxygen content of the molten steel. '643 patent, col. 7, ll. 58-68. During vacuum degassing, the carbon content of the steel is reduced to less than 0.020%. *Id.* "Al is added for deoxidation to such a degree that blow holes, etc. do not occur during the continuous casting, i.e., until

the free oxygen content is lowered to 150 ppm or less." '643 patent, col. 8, ll. 1-4. Alternatively, Al and Ti are used in combination as deoxidizing agents so the soluble Al levels are not more than 0.005% to maintain the grain structure of the steel. '643 patent, col.8, ll. 6-24.

The molten steel thus prepared is then "continuously slab cast" by "a conventional method." '643 patent, col. 2, l. 14, col. 3, l. 13, col. 8, l. 26. The '643 patent does not describe the thickness of as-cast steel slabs, or the conventional continuous slab casting methods used in 1976 when the '643 patent was filed. The '643 patent states only that the steels in Table 4, which are the focus of the present Examiner's rejection, were made by "[t]he molten steel thus obtained ... cast by a continuous slab casting machine." '643 patent, col. 9, ll. 4-6. The rejection focuses on Table 4 and particularly Sample V which discloses a steel with T-O (total oxygen) of 210 ppm and F-O (free oxygen) of 35 ppm. However, the presently claimed invention of claims 1-26 is a **method** of making thin cast steel strip, and not the composition that is produced. The rejection states that "Kumai et al. discloses a method of thin cast strip (page 2);" however, Kumai et al. discloses making a continuously cast slab **and** then hot rolling and cold rolling with a large reduction to form the cast strip. This is plainly **not** directed to the disclosed invention of the presently claimed subject matter. Kumai et al. clearly does not disclose an as-cast thin strip as specified by the claimed present method. Further, the total oxygen stated for sample V of 210 ppm is prior to vacuum degassing and not at the time of casting, as claimed by Applicants.

In short, there is no teaching or suggestion in the '643 patent that would render obvious the presently claimed method. Accordingly, Applicants respectfully request that claims 1-26 be allowed, and the application be passed to issue. Applicants also note that Claims 1-13 were already previously allowed by the Examiner in the parent application, of which the present application is a continuation-in-part.

Respectfully submitted,

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